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10/671,143

09/25/2003

Ji Ung Lee

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GENERAL ELECTRIC COMPANY  
GLOBAL RESEARCH  
ONE RESEARCH CIRCLE  
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NISKAYUNA, NY 12309

EXAMINER

MCDONALD, RODNEY GLENN

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UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE BOARD OF PATENT APPEALS  
AND INTERFERENCES

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*Ex parte* JI UNG LEE and WILLIAM HULLINGER HUBER

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Appeal 2009-000369  
Application 10/671,143  
Technology Center 1700

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Decided: January 27, 2010

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Before EDWARD C. KIMLIN, BRADLEY R. GARRIS, and  
PETER F. KRATZ, *Administrative Patent Judges*.

KRATZ, *Administrative Patent Judge*.

DECISION ON APPEAL

This is a decision on an appeal under 35 U.S.C. § 134 from the Examiner's final rejection of claims 1-57 and 99. We have jurisdiction pursuant to 35 U.S.C. § 6.

Appellants' claimed invention is directed to a method of forming a self-aligned gated carbon nanotube field emitter wherein at least one carbon nanotube is grown from a catalyst deposited on a base layer structure in a direction substantially perpendicular to a substrate surface via use of electrical field lines (Spec., para. 0008; claim 1). An electrical potential is applied to a substrate and conductor layer and generates the electrical field lines. *Id.*

Claim 1 is illustrative and reproduced below:

1. A method for fabricating a self-aligned gated carbon nanotube field emitter structure, comprising the steps of:

providing a substrate, wherein the substrate has a surface;

depositing a dielectric material on the surface of the substrate, wherein the dielectric material has a surface;

depositing a conductor layer on the surface of the dielectric material, wherein the conductor layer has a surface;

selectively etching the conductor layer to form an opening in the conductor layer;

selectively etching the dielectric material to form a micro-cavity in the dielectric material;

depositing a base layer structure in the micro-cavity adjacent to the surface of the substrate, wherein the base layer structure has a surface, and wherein the base layer structure has a substantially conical shape;

depositing a catalyst on a portion of the surface of the base layer structure, wherein the catalyst is suitable for growing at least one carbon nanotube;

applying an electrical potential to the substrate and the conductor layer, wherein the electrical potential generates a plurality of electrical field

lines that are deflected around the surface of the base layer structure, and wherein the plurality of electrical field lines have a strength that is greatest in a direction substantially perpendicular to the surface of the substrate; and

growing at least one carbon nanotube from the catalyst in the presence of the plurality of electrical field lines, wherein the at least one carbon nanotube is grown in a direction substantially perpendicular to the surface of the substrate.

The Examiner relies on the following prior art<sup>1</sup> references as evidence in rejecting the appealed claims:

Huang	5,451,830	Sep. 19, 1995
Takemura	5,620,350	Apr. 15, 1997
Lee	US 6,339,281 B1	Jan. 15, 2002
Jin	US 2004/0067602 A1	Apr. 8, 2004
Keesman	US RE38,561 E	Aug. 3, 2004
Chen	US 6,185,877 B2	Nov. 9, 2004

Zhang, "Electric Field Directed Growth of Aligned Single Walled Carbon Nanotubes", Applied Physics Letters, Vol. 79, No. 19, pg. 3155-3157, November 5, 2001.

Bowler, "Plasma included alignment of carbon nanotubes", Applied Physics Letters, Vol. 77, No. 6, pg 830-832, August 2000.

The Examiner maintains the following grounds of rejection:

Claims 1-6, 9, 13-19, 22-27, 29, 31-38, 42-48, 51, 52, 54-56, and 99 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Lee in

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<sup>1</sup> Appellants do not dispute that Jin and Chen, each of which have filing dates prior to the filing date of the subject Patent Application, are available as prior art to the here-claimed subject matter. Nor do Appellants dispute that the subject matter of Keesman (RE 38,561 E) is prior art to the here claimed subject matter (the underlying U.S. Patent No. 5,773, 921 issued on Aug. 23, 1996).

view of Jin. Claims 7, 10-12, and 39-41 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Lee in view of Jin and Keesmann. Claim 8 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Lee in view of Jin and Takemura. Claims 20, 21, 49, and 50 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Lee in view of Jin and Zhang. Claims 28 and 57 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Lee in view of Jin and Bower. Claims 30 and 53 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Lee in view of Jin, Huang, and Chen.

We affirm the stated rejections for substantially the reasons set forth in the Examiner's Answer. We offer the following for emphasis.

At the outset, we note that there are three independent claims (1, 32, and 99) subject to the Examiner's first stated obviousness rejection. The independent claims are directed to a method of fabricating a field emitter structure wherein an electrical potential is applied to a substrate and conductor layer (claims 1 and 99) or a cathode electrode and a gate electrode (claim 32) generating a plurality of electrical field lines, and wherein at least one carbon nanotube is grown from a catalyst in the presence of the electrical field lines such that the at least one nanotube grows in a direction substantially perpendicular to the substrate surface (claims 1 and 99) or to the cathode electrode (claim 32). Appellants do not argue the rejected claims separately with respect to the first stated rejection. Consequently, we primarily focus on claim 1 as a representative claim in deciding this appeal as to the first stated rejection.

Appellants rely on the arguments made with respect to the independent claims subject to the first stated rejection in traversing the

Examiner's other obviousness rejections, which other rejections employ the prior art used in the first stated rejection together with additional prior art in rejecting some of Appellants' dependent claims. Consequently, in affirming the Examiner's first stated rejection, we reach a decision that carries forward with respect to the other rejections presented by the Examiner given the commonality of the arguments presented by Appellants in traversing all of the Examiner's rejections.

### PRINCIPAL ISSUE

Have Appellants identified reversible error in the Examiner's obviousness rejections by arguing that the combined teachings of Lee and Jin are inadequate to have rendered the here-claimed subject matter obvious to one of ordinary skill in the art because Jin does not teach or suggest applying an electrical potential between a substrate and conductor layer?

### PRINCIPLES OF LAW

On appeal to this Board, Appellants must show that the Examiner erred in finally rejecting the claims. *Cf. In re Kahn*, 441 F.3d 977, 985-86 (Fed. Cir. 2006); *see also* 37 C.F.R. § 41.37(c)(1)(vii).

A claimed invention is unpatentable if the differences between it and the prior art are "such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains." 35 U.S.C. § 103(a) (2000).

The Supreme Court has instructed that although the teaching, suggestion, and motivation test "captured a helpful insight," an obviousness

analysis “need not seek out precise teachings directed to the specific subject matter of the challenged claim, for a court can take account of the inferences and creative steps that a person of ordinary skill in the art would employ.”

*KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 418 (2007).

### FINDINGS OF FACT/ANALYSIS

The Examiner has found that Lee teaches or suggests a method of forming carbon nanotube field emitter structures, including forming a micro-cavity and growing at least one nanotube in a micro-cavity, that substantially corresponds to the representative claim 1 method but for Lee explicating the application of an electrical potential to the substrate and a conductor layer (such as a conductive gate) so as to generate an electric field (electric field lines) during nanotube growth to help orient the nanotube growth of Lee in a direction perpendicular to the substrate (Ans. 3-5). Appellants do not specifically contest the Examiner’s determinations as to the teachings of Lee and the difference between the method of Lee and that recited in the appealed independent claims as outlined by the Examiner (*see generally* App. Br. and Reply Br.). Accordingly, we adopt the Examiner’s relevant factual findings as to Lee.

The Examiner relies on Jin for teaching/suggesting, *inter alia*, the use of an electrical field (electrical field lines) to help guide the growth of nanowires in a direction perpendicular to a substrate; that is, vertically (Ans. 5-6; Jin, paras. 0014 and 0050). The Examiner maintains that Jin teaches or would have suggested the application of electrical potential to the substrate and conductor layer (gate) and that the combination of Lee and Jin would have suggested using an applied potential and the generation of an electrical

field, as taught or suggested by Jin, during the nanotube growing of Lee to aid in directing the nanotube growth in a perpendicular direction to the substrate surface (Ans. 5, 6, and 12).

Appellants argue that the Examiner's proposed combination of Lee and Jin would not *prima facie* lead to the here-claimed method because Jin does not teach or suggest applying an electrical potential to the substrate and the conductor layer (App. Br. 12-13; Reply Br. 3-4).

Contrarily to the thrust of Appellants' argument, however, Jin teaches or suggests forming a gated field emitter structure wherein alignment of nanowires (carbon nanotubes) is fostered by employing an intrinsically present "electrical field [that] is applied between the gate 63 and the substrate cathode 20 during CVD growth of nanowires 65, Fig. 6(b)" (Jin, paras. 0056 and 0052). In other words, as depicted in Figure 6b of Jin, an electrical potential (voltage) is variously applied between cathode substrate 20 and conductive gate 63, so as to generate an electrical field (electrical field lines) for aligning nanowires during their growth (Jin, Fig. 6b, paras. 0028, 0050, 0056, and 0057).<sup>2</sup>

Consequently, Appellants' argument is not persuasive of reversible error in the Examiner's obviousness determination of representative claim 1 based on the combined teachings of Lee and Jin.

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<sup>2</sup> We note that Zhang, which reference is additionally applied by the Examiner in a separate rejection of dependent claims 20, 21, 49, and 50, further supports the Examiner's obviousness determination as to the use of an applied voltage in Lee for steering the nanotube growth in a particular direction because Zhang teaches use of an applied bias voltage and associated electric fields during the growth of nanotubes for orienting the nanotubes in a given direction (Ans. 9; Zhang, p. 3155-3156).

Appellants rely on the arguments made in favor of a non-obviousness determination as to the independent claims, as here-discussed with respect to representative claim 1, for all of the dependent claims, including those separately rejected over prior art in addition to Lee and Jin (Ans. 9-15). Consequently, we are not persuaded of reversible error as to any of the six obviousness rejections maintained by the Examiner.

### CONCLUSION

Appellants have not identified reversible error in the Examiner's obviousness rejections by arguing that the combined teachings of Lee and Jin are inadequate to have rendered the here-claimed subject matter obvious to one of ordinary skill in the art on the basis of the non-persuasive contention that Jin does not teach or suggest applying an electrical potential between a substrate and conductor layer.

### ORDER

The Examiner's decision to reject claims 1-6, 9, 13-19, 22-27, 29, 31-38, 42-48, 51, 52, 54-56, and 99 under 35 U.S.C. § 103(a) as being unpatentable over Lee in view of Jin; to reject claims 7, 10-12, and 39-41 under 35 U.S.C. § 103(a) as being unpatentable over Lee in view of Jin and Keesmann; to reject claim 8 under 35 U.S.C. § 103(a) as being unpatentable over Lee in view of Jin and Takemura; to reject claims 20, 21, 49, and 50 under 35 U.S.C. § 103(a) as being unpatentable over Lee in view of Jin and Zhang; to reject claims 28 and 57 under 35 U.S.C. § 103(a) as being unpatentable over Lee in view of Jin and Bower; and to reject claims 30 and

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53 under 35 U.S.C. § 103(a) as being unpatentable over Lee in view of Jin, Huang, and Chen is affirmed.

No time period for taking any subsequent action in connection with this appeal may be extended under 37 C.F.R. § 1.136(a).

AFFIRMED

PL Initial:  
sld

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